7.0 Groundwater and Vadose Zone Monitoring

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7.0.1 Groundwater Monitoring

The Hanford Groundwater Monitoring Project includes sitewide groundwater monitoring mandated by U.S. Department of Energy (DOE) Orders and near-field groundwater monitoring conducted to ensure that operations in and around specific waste disposal facilities comply with applicable regulations.

Collection and analysis of groundwater samples to determine the distribution of radiological and chemical constituents were major parts of the groundwater monitoring effort. In addition, hydrogeologic characterization and modeling of the groundwater flow system were used to assess the monitoring network and to evaluate potential effects of Hanford Site groundwater contamination. Other work included data management, interpretation, and reporting. The purpose of this section is to provide an overall summary of groundwater monitoring during 2000. Additional details concerning the Hanford Groundwater Monitoring Project are available in PNNL-13404, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*.

Groundwater monitoring was conducted to accomplish the following tasks:

- assess the impact of radiological and hazardous chemicals on groundwater as a result of Hanford Site operations
- evaluate potential offsite effects from the groundwater pathway
- verify compliance with applicable environmental laws and regulations
- evaluate effectiveness of groundwater remediation
- identify and characterize new or existing groundwater quality problems
- evaluate the potential human exposure to contaminants in groundwater.

To assess the effect of Hanford Site operations on groundwater quality, background conditions, or the quality of groundwater on the site unaffected by operations must be known. Data on the concentration of contaminants of concern in groundwater that existed before site operations began are not available. Therefore, concentrations of naturally occurring chemical and radiological constituents in groundwater sampled from wells located in areas unaffected by site operations, including upgradient locations, provide the best estimate of pre-Hanford groundwater quality. Summaries of background conditions are tabulated in several reports (PNL-6886; PNL-7120; DOE/RL-96-61; and Appendix A of WHC-EP-0595).

Groundwater samples were collected from both the unconfined and upper confined aquifers. The unconfined aquifer was monitored extensively because it contains contaminants from Hanford Site operations (PNNL-13404) and provides a potential pathway for contaminants to reach points of human exposure (e.g., water supply wells, Columbia River). The upper confined aquifer was monitored, though less extensively and less frequently than the unconfined aquifer, because it also provides a potential pathway for contaminants to migrate off the site. Some sampling also was conducted at the request of the Washington State Department of Health.

Sitewide groundwater monitoring is designed to meet the project objectives stated in DOE Order 5400.1 and described above. The effects of Hanford Site operations on groundwater have been monitored for more than 50 years under this project and its predecessors. Near-field monitoring of groundwater around specific waste facilities was performed to meet the requirements of the *Resource Conservation and Recovery Act* (RCRA) (40 CFR 265) and Washington Administrative Codes (WAC 173-303 and 173-304) as well as applicable DOE Orders (e.g., 5400.1, 5400.5). Groundwater monitoring was also performed in conjunction with cleanup investigations under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) (40 CFR 300).

To evaluate the effect of remediation efforts on groundwater, groundwater within the contaminant plumes must be monitored to characterize and define flow patterns and trends in the concentrations of radiological or chemical constituents. Monitoring is required to quantify the existing groundwater quality problem and to provide a baseline of environmental conditions against which future changes can be assessed.

New or existing groundwater quality problems must be identified and characterized. Areas that potentially could be a source of contamination were monitored to characterize and define trends in the condition of the groundwater. These areas were monitored to identify and quantify existing, emerging, or potential problems in groundwater quality. Potential source areas included active waste disposal facilities or facilities that had generated or received waste in the past. Most of these facilities are located within the 100, 200, and 300 Areas. However, some sources such as the 618-11 burial ground are located outside these operational areas.

Water supplies on and near the Hanford Site potentially provide the most direct route for human exposure to contaminants in groundwater. In 2000, one of the site's ten DOE-owned, contractor-operated drinking water systems provided groundwater for human consumption on the site. This system supplied water at the Fast Flux Test Facility (see Section 4.3). Water supply wells used by the city of Richland are located near the site's southern boundary. Monitoring wells near these water systems were routinely sampled to ensure that any potential water quality problems would be identified long before regulatory limits were reached.

Summary results for groundwater monitoring in 2000 are discussed in Section 7.1.

7.0.2 Vadose Zone Monitoring

The vadose zone is defined as the area between the ground surface and the top of the water table. This subsurface zone also is referred to as the unsaturated zone or the zone of aeration. The vadose zone functions as a transport pathway or storage area for water and other materials located between the soil surface and the groundwater aquifers. Historically, the vadose zone at industrialized and waste disposal areas at the Hanford Site has been contaminated with large amounts of radioactive and non-radioactive materials through the intentional and unintentional discharge of liquid waste to the soil column, burial of contaminated solid waste, and deposits of airborne contaminants on the ground. Depending on the makeup of the soil, the geology of the area, the nature of the waste, the amount of water or other fluids available to mobilize the contaminant, and other factors, contaminants can move downward and laterally through the soil column, can be chemically bound to soil particles (and immobilized), or can be contained by geologic formations.

Because of concerns about the effect of some vadose zone contaminants on the groundwater beneath the Hanford Site, and the potential for

contaminated groundwater to reach the Columbia River, characterization efforts are under way to learn more about the nature and extent of vadose zone contamination. At the Hanford Site, the primary method for monitoring radiological contamination in the vadose zone consists of borehole logging (monitoring radiation levels in narrow shafts bored or drilled into the soil column). Borehole logging is conducted in existing boreholes located in and around the 200 Areas single-shell tank farms and beneath former waste disposal facilities also in or near the 200 Areas. Additionally, soil-vapor extraction and monitoring are conducted as part of an expedited response action in the 200-West Area to remove carbon tetrachloride from the vadose zone.

Results for the 2000 vadose zone activities are discussed in Section 7.2. Section 7.2 has been divided into vadose zone characterization, vadose zone monitoring, and technical demonstrations related to the vadose zone.